





Economic Research Service

Climate Change and Food Security

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Issue: Global warming is likely to reduce agricultural production in the Tropics, where many developing countries are located. Policy options that could help farmers adapt to changing climates include encouraging agronomic research, providing irrigation or increasing its efficiency, maintaining or improving flood control, and facilitating human migration. Despite recent advances in analyzing the economic impacts of global warming, however, information about climatic threats to food security in developing countries is still extremely limited.

Background: Over the past 250 years, deforestation, combustion of fossil fuels, and production of agricultural commodities such as rice and livestock have caused atmospheric concentrations of carbon dioxide (CO₂) and other greenhouse gases to rise significantly. "Greenhouse" gases absorb energy radiated from Earth to space and warm the atmosphere. According to the Intergovernmental Panel on Climate Change (IPCC), increases in greenhouse gas emissions have been associated with an increase in the mean global temperature of 0.3°C-0.6°C since the late 19th century; by the end of the 21st century, according the IPCC, greenhouse gas emissions could cause the mean global temperature to rise by another 1.4°C-5.8°C.

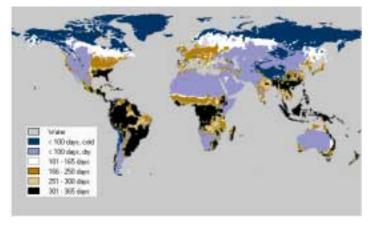
Increases in mean global temperature will have numerous effects on agricultural production, chief among them being changes in growing seasons—the length of time that soil temperature and soil moisture conditions are suitable for crop growth. The Earth's oceans will expand, raising sea levels and reducing the amount of land available for agriculture. Extreme weather events, such as storms and floods, may increase in frequency. Higher atmospheric concentrations of CO₂ will improve water-use efficiency of all crops (by reducing evapotranspiration) and increase the rate of photosynthesis of most crops. The direct effects of CO₂, however, will be small in regions where low fertilizer use or other factors inhibit crop growth. The direct detrimental effects of other fossil fuel emissions, such as sulfur dioxide and ozone, will offset some of the benefits of high concentrations of CO₂.

The U.S. Department of Agriculture's Economic Research Service (ERS) has developed a model that estimates the effects on world agriculture of climate-induced changes in growing seasons. The model links agricultural production to land classes defined by length of growing season (fig. 1). A geographical information system converts changes in temperature and precipitation generated by general circulation models of the atmosphere into changes in land classes. Model results indicate that global warming shortens growing seasons in the Tropics and lengthens growing seasons at high latitudes (fig. 2), while mid-latitude impacts are mixed. The magnitude of these effects increases as mean global temperature increases. Other studies have found similar results.

Compared with 1990 economic conditions, the model shows that these land resource changes reduce agricultural output in equatorial regions where many developing countries are located. Table 1 shows that as mean global temperature rises, agricultural production in Southeast Asia initially increases slightly, reaches a peak, and then declines. This does not mean that agricultural production in Southeast Asia will actually fall below 1990 levels. Economic growth and technological advances should

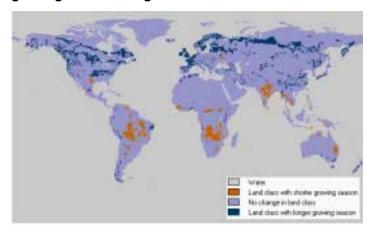
Figure 1

Land classes under initial climatic conditions



Economic Research Service, USDA

Figure 2 Increase in mean global temperature of 1.8°C is likely to shorten growing season in Tropics, lengthen growing season in higher latitudes



Note: Based on transient runs of the Hadley Centre's general circulation model. Economic Research Service, USDA

enable agricultural production to continue to increase. The equatorial region's average rate of production increase, however, will slow with global warming, and some countries could actually suffer a decline.

Alternatives. Farmers and governments worldwide have several options to counter continued, longrun global warming. Farmer adaptations, such as switching crop varieties, introducing more suitable crops, or shifting from crops to grazing, can often be undertaken by individual farmers. Governments can provide reliable 6- to 8-month weather projections or information about suitable crop and livestock alternatives to help farmers increase production efficiency. Governments can encourage agronomic research for the development (by either traditional breeding or biotechnology) of new varieties better able to withstand the effects of global warming. Agronomists may be able to increase the ability of crops to use CO2 more efficiently in photosynthesis. Other options, such as providing irrigation (or increasing its efficiency) and maintaining flood control, require long-term cooperation with farmers or other members of society. These options would benefit from reliable, longrun information about climate change and its effects on land and water resources.

As temperatures in Southeast Asia rise, agricultural production increases at first, then declines

Mean global temperature increase	Crop production change	Livestock production change
(°C)	Percent	
1.0	0.82	-0.12
1.1	0.00	0.67
1.3	0.82	0.28
1.8	-1.58	-1.39
2.8	-2.62	-1.17
4.0	-2.68	-1.83
4.2	-2.78	-2.04
5.2	-4.78	-3.15

Based on 1990 economic conditions.

Adaptation does not guarantee that farming will be able to continue in an area, or if it does, that farm incomes will remain unchanged. Some adaptation will involve shifting agricultural production from one location to another. This adaptation, too, would benefit from government policies that provide reliable, longrun information that identifies suitable and unsuitable crop locations as climate changes. Government policies that facilitate the migration of people from one location to another or the transition from one profession to another would likewise be helpful. Policies that stimulate economic growth and development and thereby provide more alternatives to agriculture as a source of livelihood would benefit farmers transitioning to new professions.

Long-term policy responses require accurate information about the economic impacts of future climatic conditions. Despite recent advances in analyzing the economic effects of global warming, information about climate change and food security in developing countries remains extremely limited. Specific details are lacking about the location, timing, magnitude, and probability with which food security issues might arise. ERS will continue to conduct economic research that helps to assess the effectiveness of public policies for responding to global warming.

Information Sources: Additional information on the impacts of greenhouse gas emissions can be found at ERS's website, www.ers.usda/Briefing/GlobalClimate.

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